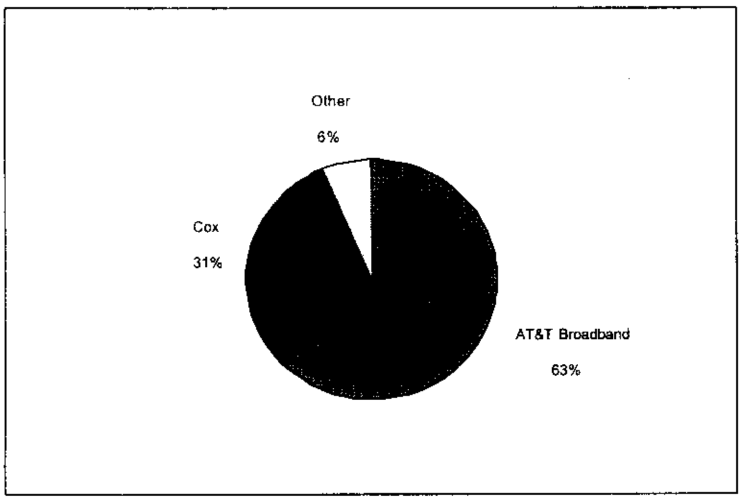
The two largest cable telephony providers offering service today are AT&T Broadband and Cox Communications. AT&T provides 63 percent of cable telephony service, or about one million subscribers.[25] Cox serves the second largest number of subscribers, about 500,000, or 31 percent.[26] Cablevision and a few other cable operators with limited telephony service offerings serve the remaining 6 percent of cable telephony subscribers. Cable operators representing roughly 65 percent of the industry are not aggressively marketing telephone services.[27]

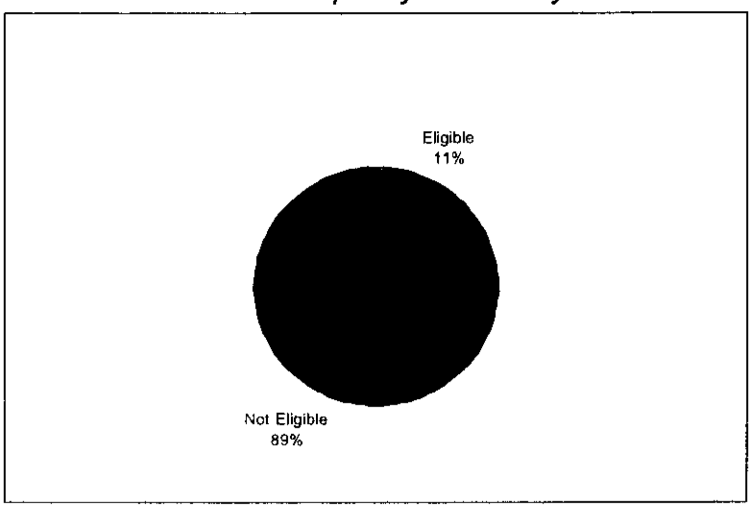
*Figure V.2*
*Cable Telephony Providers*




[25] AT&T News Release, "AT&T Announces Fourth-Quarter Earnings," January 30, 2002 "AT&T News Release, 1/30/02"), http://www.att.com/press, viewed March 13, 2002.
[26] Cox Press Release, "Cox Communications Announces Fourth Quarter Financial Results for 2001," February 12, 2002 ("Cox Press Release, 2/12/02"). http://www.cox.com/PressRoom, viewed March 13, 2002.
[27] AT&T and Cox serve 35 million of the roughly 99 million cable television homes passed. AT&T Form 10-Q For the quarterly period ended September 30, 2001. Cox Communications Inc., "Consolidated Historical and Pro Forma Statements of Operations," For the quarter ended September 30, 2001. Available at: http://www.cox.com/PressRoom/Q3%202001%20Earnings%20Release.asp, viewed March 14, 2002. National Cable Telecommunications Association ("NCTA"), "Cable and Telecommunications Industry Overview 2001," p. 16, table entitled, "Cable Industry Facts-At-A-Glance (December 2001)," referencing Paul Kagan Associates, Inc. as source for "Homes Passed by Cable" data.

Even when a cable company is marketing cable telephony service, many of its customers do not have access to the service. Network upgrades do not render all homes "telephony-ready." Cox is the oldest, most aggressive and most successful provider of cable telephony service in the US. Their fraction of telephony-ready homes passed to total homes passed likely represents a reasonable upper bound for the percentage of plant any larger operator might have supporting telephony services. As of September 30, 2001, Cox reported approximately 3.1 million telephony-ready homes out of 9.9 million total homes passed, for a penetration of 32 percent.[28] Applying this percentage to AT&T's total homes passed, and adding a gross up for the other cable telephony providers yields 11.7 million telephony-ready homes, or approximately 11.3 percent of the 103 million telephone households across the U.S. See Figure V.3.

*Figure V.3*
*Cable Telephony Availability*




[28] *Ibid.*, Cox Communications Inc., "Consolidated Historical and Pro Forma Statements of Operations," For the quarter ended September 30, 2001.

Of course, availability and penetration are much higher in particular cable telephony serving areas. The purpose of this exercise is to demonstrate the level of competition offered by cable telephony providers on a nationwide basis, and it shows that impact to date is minimal and will likely remain so for some time to come.

Cable telephony offers competition to the incumbent local exchange carriers only on a limited basis. The cable telephony competition that does exist is concentrated in certain service areas, and thus leaves a significant portion of residences and small businesses without a competitive local exchange offering from their cable television provider. The explanation for this low penetration is provided in the next section, which examines the business considerations cable operators face when they decide whether to invest in cable telephony.

### B. Cable Operator Investment Alternatives

Investment in telephony by cable operators has been inhibited by a number of factors, including competing revenue opportunities, uncertainty over potential revenue and technological uncertainty. The factors identified in this section, which include network upgrade costs, the potential for competitive response from incumbent carriers, broadband and wireless substitution, and the perception of better returns on cable provision of digital television ("DTV") and broadband data investments show that significant risk is associated with cable telephony investment.[29] These issues are discussed in Sections 1 and 2. The

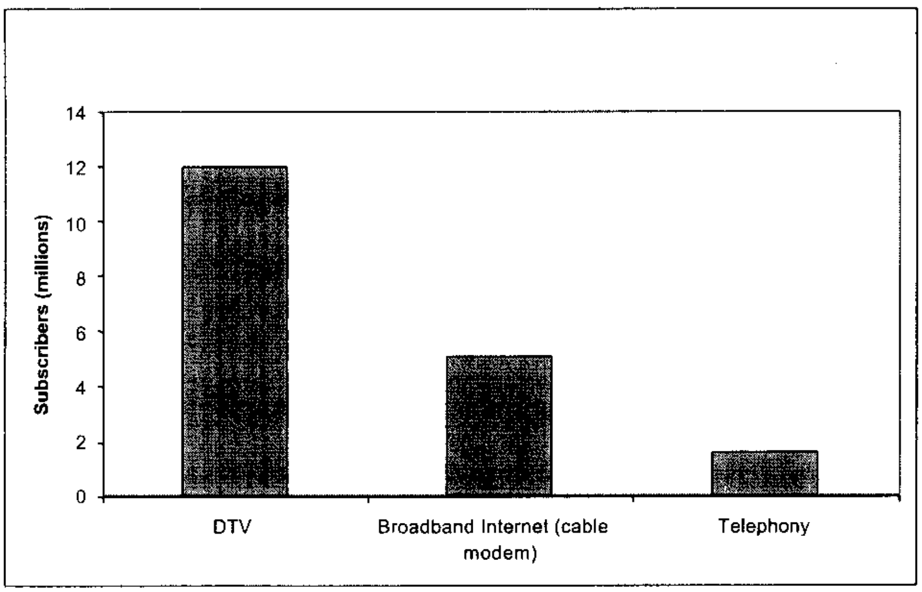
[29] HAI identified and quantified these risks in ELB II.

additional uncertainty caused by the potential for superior IP telephony technology to become available in a few years is discussed in Section C.

*1. Competing Investment Alternatives*

Although numerous multiple system operators ("MSOs") have proceeded with the expensive network rebuilds or upgrades that add capacity and two-way capability to their systems, many operators are not aggressively pursuing telephony. Instead, most MSOs are using their upgraded networks to offer DTV and broadband Internet access, also called cable modem service. Examining the relative penetration levels of these services emphasizes this point, as shown in Figure V.4.

*Figure V.4*
*Advanced Service Penetration, June 2001*[30]

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[30] *In the Matter of Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming,* CS Docket No. 01-129, Eighth Annual Report, Released Jan 14, 2002 ("*8th Annual Video Programming Report*"), pp. 19-28 and HAI estimates. Telephony penetration estimate, year-end 2001. Cox "ended 2001 with nearly half a million telephone customers...,"

There are several reasons why MSOs are more interested in DTV and cable modem service than primary line telephone service. In the mid-late 1990's many MSOs experimented with cable telephony by offering service trials. The high incremental cost of service provision, the promise of forthcoming technologies that would reduce cost and simplify operations, and the perception of better revenue opportunities through other advanced services led most MSOs to shelve their circuit switched telephony rollout plans.[31] Cox Communications was one of the few exceptions.

Additionally, MSOs saw revenue opportunities in other lines of business, such as DTV and broadband Internet access. Compared to telephony, these services are less costly to deploy, there are fewer competitors, and there was significant pent-up demand for high-speed data. Furthermore, DTV and broadband Internet did not require the same level of plant integrity as telephony, since the average customer was tolerant of occasional service outages for television and residential data services. Table V.1, which is based on cable industry estimates, shows the incremental costs of adding the various services beyond the cost of the basic network upgrades.

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Cox Press Release, 2/12/02. At the end of 2001, "AT&T Broadband had more than 1.0 million broadband telephony customers...", AT&T News Release, 1/30/02.

[31] In the mid-late 1990's Time Warner Cable, the nation's second largest MSO, had planned to offer circuit switched cable telephony to its subscribers. Those plans never became a reality outside of a few trial communities. Today, Time Warner Communications is experimenting with IP telephony as a "second line" service. Other large MSOs, such as Charter Communications are also testing IP telephony systems in lieu of offering circuit switched telephony, which could be deployed today. See, CED Magazine, "Cable Telephony: Ready to Take Off," May 1997; and Time Warner Cable Press Release, "Time Warner Cable Expands Internet Telephone Test to Rochester Road Runner Customers," January 31, 2001.

*Table V.1*
*Per Subscriber Incremental Cost of Service Provision*[32]

| | | |
|---|---|---|
| Digital Television | $250 | Set top converter and Installation |
| Broadband Internet | $160 | Cable Modem, Cable Modem Termination System, Installation |
| Telephony | $500+ | Customer Interface Unit, Host Digital Terminal, Installation, Backhaul to Switch |

These costs are in addition to the expensive rebuild or upgrades for the networks on which these services ride. Upgrades typically increase the channel capacity of the cable network and often include the activation of a return path, to allow two-way communications. Upgrades may also include the addition of equipment that will allow the cable operator to power customer premises equipment through the cable network. This equipment insures that cable telephony subscribers will not lose telephone service during power outages. The cost of such upgrades vary depending on the condition of existing plant, but typically range from $150-$350 per home passed. The cable industry has invested billions in upgrading plant in recent years.[33] But the alternative, providing advanced services over a cable system that has not been upgraded, if possible at all, requires even more investment.

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[32] Incremental cost of adding service to a network that has been upgraded to support these services. In the case of telephony, this necessarily implies two-way active plant. Although an activated return path is not required for broadband Internet or DTV service, both services are typically deployed on such plant. Presentation by Greg Braden, AT&T EVP, Broadband Services at the University of Colorado, Boulder, November 27, 2001, and HAI estimates. ("Braden Presentation")

[33] See, NCTA, "Cable & Telecommunications Industry Overview 2001."

### 2. *Pressure on Telephone Revenue*

Current pressures on local telephone service revenue may also affect a cable operator's decision to offer a telephony product. These pressures come from several sources including ILEC ability to lower the price of certain services, competition from wireless service providers, declining long distance prices, and the impact of broadband data on second line take rates.

Cable operators who offer telephony services typically price their services ten to twenty percent below the incumbent. The savings are greater for customers with more expensive telephone service. For example, in Denver, Colorado, Qwest offers unlimited local calling with a basket of enhanced features for $32.95. A comparable service package from AT&T Broadband is priced at $27.50, a savings of 17 percent.[34] A basic local service package from Qwest, with no enhanced features is priced at $14.92 with a $35 installation charge. AT&T Broadband's basic local service is $14.00 with free installation, a monthly savings of 6 percent. This pricing strategy suggests that AT&T Broadband is pursuing mainly those subscribers who purchase high-margin vertical features.

*Table V.2– Local Service Pricing*

| | | | |
|---|---|---|---|
| Unlimited Local | $32.95 | $27.50 | 17% |
| Unlimited Local with Feature Pack | $14.92 | $14.00 | 6% |

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[34] AT&T "Basic Local Only" plus the "Multi-Feature Pack," https://securebb.att.com:443/services/pricing/PricingTelephonyDetail, viewed March 13, 2002. Qwest "CustomChoice" value package, http://www.qwest.com/pcat/for_home/product, viewed March 13, 2002. Both AT&T and Qwest rates are quoted for residential services.

Business cases predicated on such pricing strategies may leave cable operators in a vulnerable position. Should competition from cable operators develop to any significant extent, the incumbent could lower prices for vertical services, thereby counteracting the financial incentive offered by a competing cable telephony service provider. The ILECs have this option because the price of vertical features far exceeds the cost of provision.[35] In addition, it is likely that the incumbents could lower the price of basic local telephone service in certain geographic locations in response to a lower-priced offering from a cable telephony operator. The results of local telephone economic cost models suggest that the ILECs could substantially lower the price of their local service offerings in many areas.[36]

Another threat to the revenue-generating capacity of a cable operator's telephony product stems from reduced demand for second line demand. Significant numbers of households are replacing second lines with either wireless phones or broadband Internet access.[37] Selling second lines is highly profitable for a cable operator because the incremental cost of adding a second line to an existing subscriber is low relative to the prices generally charged. The reduced demand for second lines can have a substantial negative effect on the business case for providing telephony in a cable system.

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[35] Vertical features, such as distinctive ringing, call waiting, and three-way calling are typically included in the software bundle provided by the switch vendor. In addition, switch capacity today is not processor limited; rather switches run out of capacity when their ports are exhausted. Because vertical features are included in the switch software bundle, and today's switches are not processor limited, the cost of providing vertical features is minimal.

[36] See, HAI local exchange proxy cost model, "HAI Model, Release 5.0a," filed with the FCC on February 16, 1998 ("HAI Cost Proxy Model"). Release 5.0a is available from the International Transcription Service, Washington, D.C.

Finally, given the recent reductions in long distance pricing and usage, potential net revenue generated via the resale of long distance service and through access charges is falling. This will have a negative impact on the revenue generated by a cable telephony service offering.

Each of these factors – the potential for targeted ILEC competitive responses, reduced second line demand, and falling long distance margins – reduce the incentive of a cable operator to invest in cable telephony.

### C. The Promise of IP Telephony

Today, all commercially deployed cable telephony is provisioned on circuit-switched networks, which involves dedicating a certain portion of the cable television network to the carriage of voice conversations, and routing calls through conventional switching equipment. Internet Protocol (IP) technology can also be used to carry voice over cable networks.

Some observers believe that this approach, known as IP telephony, or Voice over IP ("VoIP"). is more appealing than circuit switched telephony because it is possible to leverage the investment in equipment at the subscriber location among multiple services and to utilize bandwidth on the network more efficiently.[38] However, despite many years of development the technology is still not ready for deployment. To date there are no serious commercial implementations of cable IP telephony service. Cable operators that wish to

[37] JP Morgan, "Telecom Services 2001," November 2, 2001, pp. 41-42.

[38] In an IP telephony implementation, cable modem and telephony functions may be integrated in a single subscriber device. Because the underlying data transport is shared between telephony and data services, economies of scope can be realized.

provide local telephone service over their networks today must use circuit switched technology. All of the existing commercially deployed primary telephone lines serviced by cable companies are implemented on circuit switched equipment.

The lack of commercially available IP telephony technology leaves cable operators with a dilemma. They can either deploy circuit switched telephony today, or wait for IP telephony in the future. This dilemma has contributed to the decision by cable operators to focus their efforts on services other than cable telephony.

The following sections discuss the reasons why commercially-deployable IP telephony is not currently available. The technical issues holding IP telephony back revolve around the availability of certified and thoroughly tested equipment supporting IP telephony and the underlying data networks IP telephony systems require. Additional issues affecting the deployment of IP telephony include the need to train staff and deploy hardware in the field.

Even when it becomes available, IP telephony may not be the panacea that some claim. The costs of operating an IP telephony system may not be significantly lower than those of circuit switched networks; this may influence the investment decisions of the MSOs considering telephony rollouts. Finally, IP telephony service is subject to the same pressures on revenue as circuit switched telephony described in the previous section.

### 1. *Definition of IP Telephony*

IP telephony is the digitization and packetization of voice signals such that they may be carried on a variety of underlying physical data networks. In addition, there are a number of ancillary functions that are necessary to support IP telephony, including signaling, switching, security, provisioning, billing and network management. In the context of this paper, IP telephony represents an alternative to circuit switched primary line voice technology that is implemented over high-speed, high quality of service, two-way active cable plant.

### 2. *Status of IP Telephony Technology*

The most promising IP telephony technology for cable operators is defined in CableLabs PacketCable specifications. According to CableLabs,

> the basic PacketCable architecture defines what is known as "softswitch" architecture for voice-over-IP. The core set of PacketCable specifications describe how to move the basic functions that are typically consolidated on a single, expensive Class 5 central office switch onto several general-purpose servers, which leads to a low-cost, highly flexible, scalable, distributed architecture.[39]

It is likely that PacketCable will be the technology of choice for MSOs wishing to offer IP-based primary line telephone services. To date, no equipment has been certified. However, CableLabs has announced plans to certify PacketCable equipment in 2002. Any certification must be followed by, or completed in concurrence with, lab and field trials of the equipment.

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[39] CableLabs, Packetcable Project Primer, http://www.packetcable.com/packetcableprimer.html, viewed March 14, 2002.

Packetcable telephony systems presume an underlying data network based on DOCSIS 1.1 cable modems.[40] Compared to DOCSIS 1.0, with 193 modems certified over a period of several years, DOCSIS 1.1 is in its infancy. There have been some problems with ". . . the stability of underlying DOCSIS 1.1 access networks, which provide the quality of service (QoS) capabilities, including bandwidth and latency guarantees, required to offer voice over IP."[41] These issues must be addressed before IP telephony can be offered commercially.

PacketCable and DOCSIS 1.1 represent the most likely technologies for the implementation of IP telephony over cable networks. Equipment built to these standards will undergo certification and testing programs in 2002, but will be available for initial commercial deployment in 2003, at the earliest. Progress is much slower than cable companies expected, even a few years ago.[42] Therefore, cable operators interested in using IP telephony as the foundation of their telephone service offering must wait.[43]

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[40] CableLabs, Press release, "CableLabs Certifies 7 more DOCSIS 1.1 Modems, Continuing Cable Data Advances," December 20, 2001.
[41] Kinetic Strategies, Inc., "Vendors Push Cable VoIP Integration," *Cable Datacom News*, December 1, 2001.
[42] This point is emphasized by a 1998 article in Cable Datacom News, which states, "AT&T plans to deploy cable telephony services in three phases. The company will quickly launch circuit switched cable telephony I several TCI markets. By late 1999, AT&T expects to start deploying its IP telephony platform to bypass ILECs. The final step is to link AT&T's local cable IP telephony networks with the company's national packet telecom network, which is now under development, to offer end-to-end IP voice services." "AT&T Outlines Cable Telephony Strategy Three Phase Plan Calls for Migration from Circuit Switched Deployments to Pure Packet Telephony," *Cable Datacom News*, August 1998.
[43] As is typical with any new technology, a number of cable operators are conducting trials of IP telephony equipment. Some of these trials use equipment that may eventually be certified by CableLabs. This does not change the conclusion regarding the timing of IP telephony deployments as a primary access line service.

### 3. *IP Telephony Offers Minimal Operational Savings*

Although IP telephony may offer certain advantages over circuit-switched telephony, it appears that from an operational perspective an IP telephony network will be about as costly and involved as circuit switched telephony. Both technologies require many of the same functions, such as installation, provisioning, order processing, network monitoring and management, long distance interconnection, E911 service, billing, and repair.[44] In addition, significant technical expertise is required to implement and operate either technology, so learning curves and staff training requirements are similar.

Even after thoroughly tested and proven IP telephony equipment does become available, cable operators may decide not to offer primary line telephone service. The costs associated with operating IP-based and circuit switched cable telephony systems are comparable and the same revenue pressure described previously for circuit switched cable telephony service will apply. The point is, even when IP telephony does arrive, it may not be the "silver bullet" that the cable industry had hoped for; it may represent no less financial risk to the cable operators than circuit switched telephony.

### 4. *The Role of Circuit Switched Telephony*

Today, circuit switched technology is the only viable alternative for cable operators seeking to offer primary line telephone service in direct competition

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[44] Braden Presentation.

with an incumbent local exchange carrier. This fact is widely recognized throughout the industry, and by the FCC.[45]

However, since many operators such as Time Warner, Charter and others, including AT&T Broadband, have been waiting for IP telephony to become commercially available, it is unlikely that any significant investment in cable circuit switched telephony will be made in the immediate future.[46]

### D. Cable Telephony as an Option for Businesses

Cable television systems do not have the capacity to serve large numbers of business customers requiring DS-1 and higher-speed services. The reason is that, while upgraded cable systems are built with substantial capacity, the bulk of the network was built for broadcast services. Thus even upgraded networks have much more downstream (from cable operator to subscriber) capacity than upstream (from subscriber to cable operator) capacity. Furthermore, cable systems are generally built to share bandwidth among a large number of subscribers, so the upstream capacity, on a per subscriber basis, tends to be limited. Finally, due to technical limitations of the network, the bandwidth efficiency, expressed as bits per second per Hertz of bandwidth, in the upstream path is considerably lower than in the downstream. This means that cable operators realize lower upstream data rates than downstream data rates, per unit

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[45] *8th Annual Video Programming Report*, p.5.
[46] "The promise of IP telephony has a lot of operators sitting on the sidelines while the engineers at CableLabs work on certifying the first DOCSIS 1.1 equipment (modems and CMTSs) that is absolutely essential to any IP telephony implementation on cable's HFC networks." CED Magazine, "Cable telephony sending mixed signals," April 2001.

of spectrum. In sum, upstream bandwidth in a cable television network is at a premium.

Traditional private-line T-carrier circuits are dedicated to a single user and offer symmetrical capacity. Unfortunately, the cable network does not lend itself to the provision of this kind of service. Offering dedicated services of this nature would quickly exhaust the upstream capacity of even an upgraded cable network.

Dedicated circuits, like those discussed above, are much different than the broadband Internet access service now supported by many cable systems. Broadband Internet service supports relatively infrequent high-speed bursts of data to and from subscribers. Internet users typically transmit or receive data a small fraction of the time. Traditionally, the "bursty" nature of typical Internet transmissions allows cable capacity to be shared by a number of users, and no capacity is dedicated to any given user.

In addition to sharing bandwidth among many concurrent users, cable modem systems were developed under the presumption of asymmetrical data streams. Asymmetric systems work well for most Internet users since the average user consumes much more data than they transmit. An asymmetric system may even work well for a large business, but only for the provision of Internet service. In fact Time Warner offers RoadRunner Internet access to large businesses in a number of locations throughout the country, but it does not sell dedicated point-to-point carrier grade connections; presumably for the reasons discussed above.

Cable systems were for the most part built to serve residential and suburban areas. Even in those places where cable service is available in a central business district ("CBD"), it has historically been unsuitable for high-capacity business use because of its lack of reliability in comparison with telephone service. Cable television service is not critical to public safety and has not been subject to the availability requirements placed on tariffed telephone service by state regulators.

Upgraded cable networks may be suitable for the provision of Internet access to even large businesses, but the shared nature of the cable network, and its limited upstream bandwidth make it unsuitable for the provision of symmetric, dedicated, private-line services.[47]

### E. Conclusion

Only a small number of residences and businesses actually have a local access option through their cable provider today. Where these options do exist the de facto technology is circuit switched cable telephony. While IP telephony holds promise for the future deployment of local telephone service over cable networks, the systems supporting this technology are in their infancy. As a result, commercially available IP telephony in the local exchange is not currently available.

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[47] The development of IP telephony technology does not change this conclusion. While IP telephony provided over CATV networks may someday provide a viable alternative to circuit switched business telephone services, it will not support the kind of dedicated network facilities discussed in this section.

For all of the reasons discussed in this section, it is premature to make policy decisions on the presumption that telephony through cable systems will become a pervasive or effectively competitive offering.

## VI. Mobile and Portable Wireless Technologies

There are several independent reasons why wireless technologies developed for cellular and personal communications services cannot be used to displace wireline telephone service to any significant extent. First, demand for mobile and portable wireless service continues to expand at a high rate, and existing and planned technologies cannot serve both this demand and any significant fraction of wireline demand. Section A demonstrates this fact with a detailed technical capacity analysis. Numerous current news articles discussing deteriorating service quality for mobile and portable wireless subscribers are further evidence of this problem.

A second problem is that wireless suffers from coverage and quality problems. Wireless coverage is marginal or inadequate inside many buildings, including offices as well as homes. There are as well many outdoor coverage "holes," even in urban areas, in which signal levels are barely adequate. Indoor coverage in such areas is essentially useless. The only way of improving coverage involves adding significant numbers of cell sites in heavily populated areas, a process which is enormously expensive and which often faces virulent community opposition.

Digital wireless voice quality is lower than corresponding wireline voice quality, because wireless systems require low-bit-rate voice encoding techniques to use the assigned spectrum efficiently. Such coding techniques do not provide voice quality on a par with that offered by the higher-bit-rate techniques used in the wireline network.

Finally, current and next-generation digital cellular and PCS technologies support only relatively low data rates that are inadequate for web browsing and other Internet related applications. This will inhibit some customers from giving up their wireline for wireless service.

Various fixed wireless technologies, which compete directly with the CLECs building fiber rings, are discussed in Section VII.

### A. Wireless and Wireline Demand

Average per-subscriber wireline telephone use, expressed either as minutes per use per month or in telephone traffic terms, has historically been much greater than wireless usage. For purposes of network capacity analysis, it is most useful to consider wireless and wireline usage in traffic engineering terms. A common assumption has been that wireless subscribers generate one-fifth of the busy-hour traffic that the typical wireline subscriber generates in the busy hour. Appendix A demonstrates that, although this ratio has decreased somewhat, a wireline subscriber still generates about three times the busy-hour traffic of a wireless subscriber. Reductions in the effective price per minute of wireless service, coupled with widely-available bulk calling plans, have contributed to this increase in wireless usage.

Nonetheless, the average wireline subscriber still generates much more local traffic than the wireless user, and wireline per-subscriber usage is growing as well.[48] The net result is that, in terms of traffic alone, a wireline user requires three times the network capacity resource of a wireless subscriber.

### B. Wireless Network Capacity and Coverage

Wireless service quality today is notoriously poor in many markets, a fact that has been widely reported in the general press.[49] Wireless carriers are to a large degree victims of their own marketing success and have had much difficulty in providing facilities to meet increasing demand.

*1. Technical Limitations and Business Considerations*

A wireless network's service quality depends on two critical factors: there must be sufficient resources (radios) equipped in each cell site to serve subscriber demand in that cell, and there must be a sufficient number of cell sites located properly to ensure adequate signal strength, or "radio coverage," within the service area, both outdoors and within buildings.

A cell site represents a significant investment, often exceeding a million dollars for a site with large towers. Due to the limited coverage areas of cells in built-up areas, wireless carriers usually cannot rely on conventional commercial transmitter sites, such as those located on geographical prominences in a metropolitan area, for a significant amount of their coverage. That is, many cells are required so those on geographical prominences can only provide partial coverage. They must also lease or purchase many other sites around a

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[48] See, *e.g.*, FCC, "Trends in Telephone Service," Industry Analysis Division, Common Carrier Bureau, August 2001 ("Trends in Telephone Service"), table 11.2, p. 11-4.
[49] See, *e.g.*, Jeffrey Selingo, "Complaints skyrocket along with cellphone use," *The New York Times*, reprinted in *The Denver Post*, February 18, 2002, p. 1E.

coverage area, construct masts for antennas that may be anywhere from a few tens of feet to well over a hundred feet in height, construct a hut or small building to contain radio and backhaul transmission equipment, buy and install this equipment, and arrange for backhaul transport to connect the cell site to the switched network via a wireless switching center.

This process also involves obtaining local approval for the site itself, which can be very difficult and time consuming. Municipalities quite often object to the presence of such facilities for esthetic reasons, and, more recently, out of concern for perceived biological hazards caused by the non-ionizing radiation generated by the cell-site radio equipment.[50]

Cell sites cannot contain arbitrarily large numbers of radios, both for engineering reasons and because the carrier has a limited amount of spectrum available under its license to serve subscribers. Practical technical limitations prevent cell sites from being configured with enough radios to exhaust the carrier's assigned spectrum. Many cell sites, particularly in urban areas, are thus out of capacity and simply do not have the ability to serve additional mobile and portable users, certainly not the high number of additional users that would result if wireline users began switching to wireless in substantial numbers. Appendix B discusses these capacity limitations in greater detail.

It makes no sense from a business standpoint for wireless carriers to attempt to displace wireline telephone service. As is discussed in Appendix A, wireline subscribers served by wireless networks require considerably more of the network resources per subscriber than do mobile/portable wireless users, and wireline per-subscriber traffic continues to increase.

As discussed above, and in Appendix A, the traffic generated by a wireline subscriber is about three times that of a mobile/portable wireless user. One wireline subscriber who shifts to wireless thus displaces an average of three mobile/portable subscribers. According to the Cellular Telecommunications and Internet Association ("CTIA"), the average local wireless service bill as of June 2001, was $45.56. Assuming fixed capacity in the wireless system, the opportunity cost to the wireless carrier is significant. The FCC reports that, in 2000, the average per-subscriber monthly telecommunications expenditure was $35.[51] Under the assumption that this value is increasing at the rate of one dollar per month annually, the corresponding value for June, 2001, is about $36.50. The opportunity cost to the carrier per fixed wireless subscriber is therefore about $100 per month. [52]

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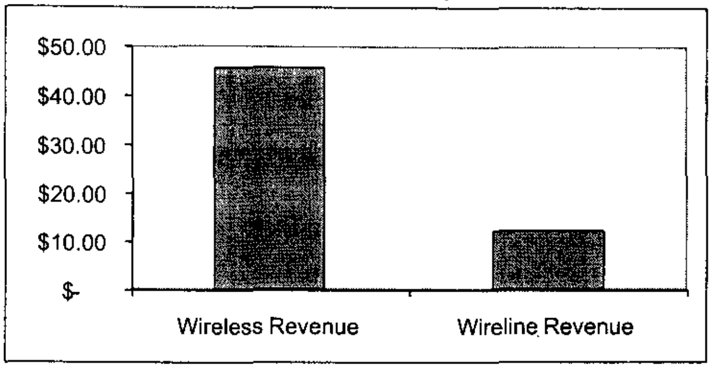
[50] Whether the hazards are real or imagined remain to be proved. The perception, however, is quite real.

[51] Trends in Telephone Service,, Table 3.2, p. 3-4. This value also presumably includes intra-LATA toll charges, as it represents average monthly payments made to ILECs and CLECs. We will, however, conservatively assume that intra-LATA charges are not included.

[52] There will of course be cells with excess capacity, particularly in low density areas. In these cases the opportunity cost will be much lower. The ability to exploit such capacity is likely limited to less densely populated areas.

*Figure VI.1*
*Wireless Opportunity Cost*




Wireless carriers are now striving to find ways of better serving their current demand and are finding few alternatives, much less alternatives that would allow them to expand significantly. As one analyst has noted:

> There is little new wireless spectrum set to become available in the near future. The outline set by former President Clinton has fallen by the wayside, and spectrum in the 1710-1850 MHz and 2500-2690 MHz bands seems farther away from being available now than it was a year ago. The PCS reauction (Nextwave) issue has yet to be resolved, and the 700 MHz spectrum scheduled to be auctioned this year has a variety of flaws, in our view.[53]

Once suitable spectrum is reallocated, it is a certainty that the spectrum licenses themselves will be very expensive for wireless carriers.

Beyond the cost of the new licenses, enormous investments will be required for new infrastructure and subscriber equipment compatible with the new frequencies. It is not likely that wireless carriers would even attempt to attract large numbers of wireline subscribers in the face of the financial pressures

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[53] Kevin Roe, *et al.*, "US Wireless Telecom 2002: The Odds Are Better; Place Your Bets,", ABN-AMRO, February 7, 2002, p. 12.

that inevitably will underlie the introduction of third generation ("3G") technology in new spectrum.[54]

The opportunity cost concern is also the probable reason why papers and articles discussing the need for additional spectrum to accommodate expanded 3G system capacity do not address significant degrees of displacement of wireline telephone service by wireless systems. The President's Council of Economic Advisers ("CEA"), for example, published a report in 2000 on the economic benefits of 3G wireless technology.[55] This report contains no mention of such displacement of service. It does include a revenue analysis with revenue expressed per megahertz of allocated bandwidth and uses that value to estimate the service revenues that would flow from an increased spectrum allocation. The CEA's analysis and conclusions would be much less sanguine if significant wireline displacement were anticipated and the corresponding opportunity cost factored into the study.

*2. Coverage and Quality issues*

A wireless subscriber may receive wireless service in a home or office by just employing his or her handheld wireless phone or by using a specialized wireless device, such as those made by Telular Corporation, which is specifically designed for fixed use.[56]

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[54] See Tim Kridel, "3G: Accidents Will Happen," *The Net Economy*, June 25, 2001, for a discussion of this and related issues.
[55] The Council of Economic Advisers, "The Economic Impact of Third-Generation Wireless Technology," October, 2000.
[56] Telular Corporation, Dial Tone and Data for the Wireless World, Products, http://www.telular.com/products, viewed March 14, 2002.

In the first case, in which subscribers simply use their portable wireless phones as wireline replacements, indoor radio coverage is obviously critical. It is, however, all too often either marginal or inadequate, even in urban and suburban areas. There has been considerable press coverage of the inadequacies of wireless service, including poor signal strength in cities.[57] Furthermore, even if a usable signal exists in a certain location in a house or office building, other locations, especially basements and lower floors and areas away from windows, will likely not exhibit adequate signal strength, so users must stand or sit in very specific locations in order to maintain acceptable voice quality (or worse, to maintain the wireless connection). This effect is well-known to anyone who has attempted to use a wireless phone indoors.[58]

Even outdoor coverage is often spotty in urban areas, particularly in densely-populated central business districts among tall buildings. Coverage is better on the upper floors of tall buildings than it is in lower floors and at street level, and signal strengths further deteriorate progressively as they travel farther into building interiors.[59] Again, any wireless subscriber with a handheld wireless phone is well-acquainted with the common need to wander around the typical office building in an attempt to find a location with sufficient radio signal strength to conduct a voice conversation of adequate quality.

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[57] See, Selingo, *supra.* note 49.

[58] The predominant means of signal propagation for wireless systems in built-up areas is scattering and not line-of-sight transmission. The communications "channel" in this case is a variety of paths between the transmitter and receiver, each of which typically consists of a series of reflections from buildings and other large objects. The individual paths are independently corrupted, and the received signal strength can only be predicted using statistical methods.

[59] Theodore S. Rappaport, *Wireless Communications Principles and Practice,* Second Edition, Prentice-Hall PTR, Upper Saddle River, NJ 2002, p 166.

Despite these problems, it is clear that there is, and will continue to be, some small fraction of subscribers who use wireless phones exclusively. A recent trade news article indicates that 1.7 percent of U.S. households use wireless phones in place of landline service.[60] One can easily imagine that members of certain classes of subscriber such as young singles living alone might rely exclusively on their wireless phones for all their telephone service. (and whose home wireline service usage is likely considerably lower than, say, that of a typical family). This presupposes, though, that these subscribers live in areas in which wireless coverage is adequate even inside their homes. As was discussed earlier, wireless coverage continues to be substandard even in many urban and suburban areas, and it is difficult and expensive for carriers to improve it.

A few wireless carriers encourage potential subscribers to use their wireless service in place of wireline telephone service. Cricket Communications, for example, offers a prepaid, flat rate, local-only wireless service in a number of markets, and Cricket television commercials (directed primarily at the young singles market noted above) exhort prospective subscribers to use the Cricket service as their primary telephone service at home. Cricket's approach is to convince potential customers that their wireless service can be affordable, particularly if the subscriber can do away with his or her existing wireline telephone service. Cricket's service is very basic and does not include bundled

[60] Cellular Telecommunications and Internet Association web site, "Study Finds More Consumers Pulling the Plug on Fixed-Line Phones," January 30, 2002, http://www.wow-com.com/news/daily-news/pub_view.cfm.

vertical features or toll service, although these are available for additional charges.

In the second case, a subscriber may use a "fixed" wireless telephone with an integrated antenna. Such a phone operates in an identical fashion to a wireline telephone (it generates dial tone, the user dials using a normal keypad, etc.), and the phone contains circuitry to interface the common telephone functions with the integrated wireless components. Another option is a fixed wireless terminal that has a standard RJ-11 telephone jack and allows the subscriber to connect a common wireline telephone or fax machine. Either of these devices can be used with an external antenna mounted directly on the device and which likely offers slightly improved performance over the antenna integrated into typical handheld wireless phones. These units also can be used with higher-gain antennas mounted outdoors and connected to the unit via coaxial cable.

The use of an external antenna can improve the signal delivered to the wireless phone. These antennas typically have higher gain than those on portable units (meaning they intercept more of the power transmitted by the wireless cell-site transmitter and are thus "directional") and also avoid the building penetration problem. They also require mounting in a suitable location, possibly on a mast, and the connection between the antenna and the fixed wireless phone must be protected from lightning strikes. Deployment of external antennas invariably requires professional installation. Because such antennas are directional, they must be pointed in the correct direction and suitably attached to the building structure. This increases the per-subscriber investment on the part of the carrier, thus increasing the opportunity cost.

There are at least two recent and pertinent examples of failed attempts to replace wireline service with wireless service using dedicated networks. AT&T, over the past several years (and before it spun off its wireless operation), spent heavily ($1.3 billion) on Project Angel, a new wireless technology expressly designed for fixed voice and data service.[61] AT&T's motivation was the development of a wireless service to complement its cable telephony service in order to expand its options for serving end users directly, thereby avoiding access charges and the costs and aggravation of attempting to lease loops from ILECs. After several years of development, AT&T finally introduced its fixed wireless service in Fort Worth in 2000, with plans to expand to 1.5 million subscribers by the end of 2000 and 10 million by the end of the following year.[62] They only made it to about 47,000 total subscribers.

In a clear statement of its lack of interest in the fixed market, AT&T Wireless, once it was spun off by its parent in July, 2001, wasted little time in unloading the Project Angel technology, associated staff, and the few subscribers actually served by the fixed system. It sold the Project Angel assets to Netro Corporation for $16 million in cash plus stock. Netro has equipped a number of fixed wireless networks internationally, most typically in areas such as Eastern

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[61] AT&T Wireless News Release, January 29, 2002. AT&T goes on to say in this release that it "intended to exit the fixed wireless business."
[62] John Borland, CNET News, March 22, 2000.

Europe that do not have extensive and well-maintained wireline communications networks.[63]

Ionica is another prominent example of a company that based its business plan on its hopes of displacing wireline telephone subscribers with a fixed wireless service. The UK-based company developed a sophisticated fixed wireless technology to compete with British Telecom for fixed voice and data services. Its business plan was apparently based on a modest penetration of the UK market of seven percent (about 2.8 million subscribers), but the company failed in 1998 with a total subscribership of about 62,000. Analysts blamed technical and financial problems for the failure.[64]

### C. Wireless Data Service for Wireline Replacement

An increasing share of landline usage is for data applications. However, new mobile wireless data services are not a significant threat to displace this landline usage. Second-generation wireless systems can support only modest data rates, typically about 10 kbps. The improved radio transmission technologies classified as 2.5G systems can support rates of several tens of kilobits per second per subscriber (for 2.5G code division multiple access, or "CDMA," about 64 kbps per subscriber), which are comparable to the rates achievable with a current voiceband dialup modem on a wireline connection.

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[63] http://www.netro-corp.com/netroframelayoutnnpc.html
[64] Chiyo Robertson, "Ionica collapses as white knight bails out," October 30,2000, at http://news.zdnet.co.uk, and "Ionica lays off 600 employees," November 2, 1998, at http://news.bbc.co.uk.

These increased per-subscriber data rates, however, come at the expense of dedicated additional radio resources to a single user.[65]

Third-generation wireless systems will offer data rates exceeding 144 kbps, even for high-mobility traffic. This value, in fact, is a threshold number often used to define, at least in part, a 3G technology. Corresponding rates for pedestrian and "indoor" users, such as a person in an airport lounge with a radio modem connected to a laptop computer, range up to 2.4 Mbps or so.

What is often misunderstood about these rates is that they represent an overall radio channel data rate, and the channel is shared among many subscribers using packet radio techniques. The average per-subscriber rates are much lower, probably between 50 kbps and 100 kbps, depending on the number of subscribers and their usage characteristics.

This fact, coupled with the radio coverage and capacity issues discussed earlier, suggests that wireless systems, even using the latest available technology, are unsuitable for supporting a large number of displaced wireline data users. Displacement of significant numbers of asymmetric DSL ("ADSL") subscribers is very unlikely, both from a capacity and service quality point of view. Furthermore, such business-oriented wirelines services as high-bit rate DSL ("HDSL") and g.shdsl cannot be supported in any quantity by wireless

[65] Even higher per-subscriber rates can be made available with 2.5G technology, but this inevitably requires dedicating extra radio capacity to a single user, thus displacing several voice channels. With 2.5G GSM techniques, for example, a single user effective rate of about 384 kbps can be achieved, but at the cost of dedicating eight time slots, or voice channels, to that user. Similar reassignment of radio capacity is required to obtain 2.5G CDMA per-subscriber rates of about 64 kbps.

systems because of the requirement for dedicated capacity in the radio system and because of quality of service concerns.[66]

### D. Wireless Industry Structure

The current structure of the mobile wireless industry provides another basis for skepticism that this platform will challenge the ILEC monopoly. Many of the largest wireless carriers are owned by ILECs. These firms do not have an incentive to engineer their systems and market their services to provide a direct substitute for landline networks. The control over the wireless industry by the ILECs may grow as the FCC eliminates its wireless spectrum cap.

### E. Conclusion

While wireless provides an adequate substitute for ILEC fixed narrowband services for a limited subset of consumers, this platform is not in a position to limit the exercise of ILEC market power. There is insufficient capacity for wireless services to discipline ILEC pricing. Quality is lower along a number of dimensions. Wireless does not support Internet access even at the rates available from narrowband connections. Finally, the wireless industry is increasingly controlled by ILECs.

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[66] Also known as G.991.2, g.shdsl, is an international standard for symmetric DSL ("SDSL") developed by the International Telecommunications Union ("ITU"). G.shdsl specifies a technique for sending and receiving high-speed symmetrical data streams over a single pair of copper wires at rates between 192 kbps and 2.31 Mbps.